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14. ABSTRACT

A Battle Management Language (BML) is an unambiguous language used to command and control forces and systems conducting military operations. BML digitizes command & control information such as orders and plans to be understandable by military personnel, simulated forces and future robotic forces. The need to interface Command and Control (C2) systems with simulation systems has been recognized by NATO bodies for defence planning, training, exercises and support to operations. A multinational effort is necessary to define and standardize an improved C2-Simulation interoperability framework and a Coalition BML (C-BML) will help fulfil this requirement. This effort has been undertaken by the NATO RTO's MSG-048 Task Group starting with 2006. A key activity under the terms of reference of MSG-048 is that of education and dissemination of information relating to C-BML and the activities of the group itself. The MSG-079 C-BML Workshop was organized by a sub-committee from MSG-048 to help fulfil this requirement and was held at Farnborough in the UK in February 2010. This workshop also provided a unique opportunity for a wide audience to present and discuss some key challenges facing C-BML development, and in some cases potential solutions.

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RTO MEETING PROCEEDINGS **MP-MSG-079**

2010 Coalition Battle Management Language Workshop

(Atelier 2010 sur le langage de gestion du champ de bataille pour les opérations en coalition)

Papers presented at the NATO Modeling and Simulation Group (NMSG) Workshop held in Farnborough, United Kingdom, 24-25 February 2010.

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The Research and Technology Organisation (RTO) of NATO

RTO is the single focus in NATO for Defence Research and Technology activities. Its mission is to conduct and promote co-operative research and information exchange. The objective is to support the development and effective use of national defence research and technology and to meet the military needs of the Alliance, to maintain a technological lead, and to provide advice to NATO and national decision makers. The RTO performs its mission with the support of an extensive network of national experts. It also ensures effective co-ordination with other NATO bodies involved in R&T activities.

RTO reports both to the Military Committee of NATO and to the Conference of National Armament Directors. It comprises a Research and Technology Board (RTB) as the highest level of national representation and the Research and Technology Agency (RTA), a dedicated staff with its headquarters in Neuilly, near Paris, France. In order to facilitate contacts with the military users and other NATO activities, a small part of the RTA staff is located in NATO Headquarters in Brussels. The Brussels staff also co-ordinates RTO's co-operation with nations in Middle and Eastern Europe, to which RTO attaches particular importance especially as working together in the field of research is one of the more promising areas of co-operation.

The total spectrum of R&T activities is covered by the following 7 bodies:

- AVT Applied Vehicle Technology Panel
- HFM Human Factors and Medicine Panel
- IST Information Systems Technology Panel
- NMSG NATO Modelling and Simulation Group
- SAS System Analysis and Studies Panel
- SCI Systems Concepts and Integration Panel
- SET Sensors and Electronics Technology Panel

These bodies are made up of national representatives as well as generally recognised 'world class' scientists. They also provide a communication link to military users and other NATO bodies. RTO's scientific and technological work is carried out by Technical Teams, created for specific activities and with a specific duration. Such Technical Teams can organise workshops, symposia, field trials, lecture series and training courses. An important function of these Technical Teams is to ensure the continuity of the expert networks.

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2010 Coalition Battle Management Language Workshop

(RTO-MP-MSG-079)

Executive Summary

A Battle Management Language (BML) is an unambiguous language used to command and control forces and systems conducting military operations. BML digitizes command and control information such as orders and plans to be understandable for military personnel, for simulated and robotic forces. In addition, BML provides the capability to exchange the required context through digitized reports for establishing and maintaining situational awareness and a shared common operational picture. BML is particularly relevant in a network-centric environment for enabling mutual understanding. BML must also facilitate Command and Control (C2) to simulation interoperability in an age where multi-national distributed integrated capabilities are becoming more common and important.

During 24th and 25th February 2010, MSG-079, a Workshop focused on C-BML (Coalition BML) was organized in Farnborough, UK with a presence of more than 60 people and 26 presentations with participation from 12 Nations and with the following objectives:

- Illustrate how the C-BML satisfies the operational needs of coalition forces;
- Provide an overview of the elements that comprise BML, why they are necessary and discuss the related challenges, relevant technologies and various technical approaches associated with BML-enabled solutions;
- Inform the NATO community on the development and use of C-BML and give an opportunity for the Nations and industry to provide a brief update on their related activities; and
- Present the goals of MSG-048 as well as the lessons learned from the 2009 experimentation and introduce MSG-085, the follow-on technical activity.

The Workshop programme was arranged into eight sessions as follows:

1) BML Operational Requirements	5) Perspectives on BML
2) MSG-048 (C-BML) Overview	6) C2-Simulation Interoperability
3) BML in Theory and Practice	7) JC3IEDM and BML
4) BML Coalition Developments	8) Other BML Research Activities

The following areas and conclusions were identified as most benefited from C-BML contribution:

- C-BML is a developing standard which shows great promise, particularly in times of constrained budgets and operational complexity;
- C-BML must adapt to the requirements of the C2 community, not vice versa;
- C-BML is seen as having great potential as an enabler for achieving C2-simulation and C2-robotic forces interoperability; and finally

- C-BML can greatly enhance legacy C2 systems' capabilities by giving them access to a wide variety of M&S functionality, e.g. course of action analysis in support of decision support capabilities.

A number of consequent recommendations concerning the coordination, development, standardisation, future use and technical development of C-BML are made. These relate to:

- The establishment of a C-BML Community Of Interest (COI);
- Stakeholder identification and involvement;
- Examining the potential benefits of C-BML;
- Standardisation activities (including related MSDL and MIP standards);
- Application areas focusing on C2-SIM and C2-robotics; and
- The decoupling of C-BML message and information transfer standards.

Atelier 2010 sur le langage de gestion du champ de bataille pour les opérations en coalition

(RTO-MP-MSG-079)

Synthèse

Le langage de gestion du champ de bataille (Battle Management Language – BML) est un langage dépourvu d'ambiguïtés qui est utilisé pour commander et contrôler les forces et les systèmes dans la conduite des opérations militaires. Le BML numérise les informations de commandement et de contrôle tels que les ordres et les plans pour les rendre compréhensibles aux militaires et aux forces simulées et la robotique. De plus, au travers de rapports numérisés, le BML permet d'échanger les informations de contexte nécessaires afin d'établir et de maintenir la connaissance de la situation et de partager une vision opérationnelle commune. Le BML est particulièrement adapté, dans un environnement réseau-centrique, pour établir une compréhension mutuelle. Le BML doit aussi faciliter l'interopérabilité de la simulation du commandement et du contrôle (C2) à une époque où les capacités intégrées multinationales distribuées deviennent plus communes et plus importantes.

L'atelier MSG-079 spécialisé sur le C-BML (Coalition BML) a été organisé à Farnborough au Royaume-Uni les 24 et 25 février 2010, avec plus de 60 personnes appartenant à 12 pays et 26 présentations dont les objectifs étaient les suivants :

- Illustrer la façon dont le C-BML satisfait les besoins opérationnels des forces de la coalition ;
- Fournir une vue d'ensemble des éléments constituant le BML, expliquer leur nécessité et débattre sur les défis connexes, les technologies pertinentes et les approches techniques variées associées aux solutions permises par le BML ;
- Informer la communauté de l'OTAN sur le développement et l'utilisation du C-BML et offrir la possibilité aux nations et à l'industrie de faire un point succinct de leurs activités relatives ; et
- Présenter les objectifs du MSG-048 ainsi que les enseignements tirés de l'expérimentation 2009 et présenter le MSG-085, activité technique à venir.

Le programme de l'atelier a été organisé suivant les huit sessions ci-dessous :

1) Exigences opérationnelles BML	5) Perspectives BML
2) Vue d'ensemble MSG-048 (C-BML)	6) Interopérabilité de simulation-C2
3) BML en théorie et en pratique	7) JC3IEDM et BML
4) Développement du BML coalition	8) Autres activités de recherche BML

Les domaines et conclusions suivants ont été identifiés comme étant ceux qui ont le plus bénéficié de l'apport du C-BML :

- Le C-BML est un standard de développement qui présente d'importantes possibilités de développement, particulièrement en ces temps de budgets contraints et de complexité opérationnelle ;

- Le C-BML doit s’adapter aux exigences de la communauté C2, mais pas l’inverse ;
- Le C-BML est crédité d’un fort potentiel pour faciliter la réalisation de l’interopérabilité de la simulation des C2 et des C2 robotiques ; et enfin
- Le C-BML peut grandement améliorer les capacités des systèmes C2 existants en leur donnant accès à une grande variété de fonctionnalités M&S, par exemple l’analyse de l’action en cours comme soutien de l’aide à la décision.

Un certain nombre de recommandations conséquentes ont été faites concernant la coordination, le développement, la standardisation, l’utilisation future et le développement technique du C-BML. Ces recommandations portent sur :

- L’établissement d’une communauté d’intérêt C-MBL (Community Of Interest – COI) ;
- Identification et implication des parties prenantes ;
- Examen des avantages potentiels du C-BML ;
- Activités de standardisation (comprenant les standards MSDL et MIP associés) ;
- Domaines d’application s’intéressant à la simulation C2 et à la robotique C2 ; et
- Découplage des standards de messages C-BML et de transferts d’informations.

Technical Evaluation Report

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OVERVIEW

The NATO Modelling and Simulation Group MSG-048 "Coalition Battle Management Language (C-BML)" organized an unclassified workshop in Farnborough, United Kingdom, on 24-25 February 2010, on the subject of C-BML. An audience of approximately 60 persons attended the workshop, with representatives from NATO, NATO/Partners-for-Peace (PfP) and other nations. The audience was diversified and was composed of attendees from the military, government R&D laboratories and a significant representation from industry. A total of twenty six (26) presentations were provided during the two days, preceded by three keynote presentations. This report presents a technical evaluation of the various presentations and technical discussion that occurred during the workshop and provides recommendations based thereon.

Participation included representation from twelve (12) nations including: Canada, Denmark, France, Germany, Great Britain, NATO NC3A and RTO, Netherlands, Norway, Spain, Sweden, Turkey and the United States of America. Participation was divided evenly between government (45%) and industry (45%) with 10% participants from academia.

1.0 INTRODUCTION

The C·BML technology is gaining both attention and recognition from the military, in particular with the latest achievements of the MSG·48 group. As this group is completing its last round of activities, a conference on the theme of C·BML was highly anticipated in order to: (l) measure the technical readiness level of the technology; (2) provide a forum for discussion amongst the C-BML, Community of Practice (CoP) and to a larger extent in the Community of Interest (CoI); and (3) present the latest developments in the C-BML arena. This report will provide a summary for each of the previously stated objectives, and make recommendations based on the current C-BML technology technical situation and observed trends for its development.

C-BML was identified several years ago as a key technology to enable the interoperation of real world military Command and Control (C2) systems and simulation systems. Its initial development although slow, was accelerated thanks to the activities conducted during the MSG-048 group, which has consequently re-energized the Simulation Interoperability Standard Organization (SISO) Product Development Group (PDG) in charge of the formulation, development and standardization of C-BML. The number of presentations within the MSG-079 conference and their technical level provide another indication about the recent interest in the C-BML CoI with a notable representation from the industry.

C-BML has as its other (secondary) objectives to provide a means for achieving the interoperability of C2 systems with other C2 systems, or between C2 and robotic forces. The former objective often has been recognized as out of the scope of C-BML – it is generally recognized that it falls under the mandate of the

Multilateral Interoperability Program (MIP) rather than SISO. The latter objective is receiving a growing attention as demonstrated by some presentations.

This conference also provided a unique opportunity for a wide audience to present and discuss some key challenges facing C-BML development, and in some cases potential solutions. Also, of equal importance to the challenges are the limitations of the technology, whether they are based on technical basis, or as will be explained later in the report on cultural causes. It is of prime importance to understand these limitations in order to provide the adequate solutions, or to restrain the employment of the technology to a limited scope. This report will also provide a portrait of the current challenges and make recommendations for future actions, as applicable.

2.0 WORKSHOP PROGRAMME

Following the opening of the workshop, three keynote speakers made presentations. The rest of the workshop was comprised of 8 sessions, as shown in table 1. The workshop programme can be found in Annex A. The presentation proceedings can be found at: http://myrto.rto.nato.int/msg/MSG-079/default.aspx.

Table 1: MSG-079 C-BML Workshop Session.

Day 1 - Feb 24th 2010	Day 2 – Feb 25th 2010
1. BML Operational Requirements	5. Perspectives on BML
2. MSG-048 (C-BML) Overview	6. C2-Simulation Interoperability
3. BML in Theory and Practice	7. JC3IEDM & BML
4. BML Coalition Developments	8. Other BML Research Activities

3.0 EVALUATION

This section summarizes the presentations and discussions that took place during the keynote addresses and the eight sessions. Overall, the presentations covered a comprehensive set of complementary views of C-BML and shared insight based on experiments and other research activities. The workshop organization was excellent and the quality of the presentations was generally quite good. In general, sufficient time for questions led to several significant discussions.

There was a clear consensus concerning the usefulness and applicability of C-BML for NATO, including support for further involvement of NATO (e.g. NC3A) in future C-BML activities, such as MSG-085. There was also a strong agreement on the importance of establishing an international C-BML standard. After a period of modest progress, recent advances by SISO in the development of the SISO C-BML specification received a strong positive reaction from stakeholders.

Also expressed almost unanimously, was the need for closer involvement between the C-BML community and the operational community – consummated with a recommendation to create a C-BML Community of Interest (COI). In particular, several representatives from the MIP were present and actively engaged in discussions concerning how to ensure better communication between the MIP and C-BML communities.

3.1 C-BML Past and Present

For over two millenniums armed forces have used many different means for communicating information. The Native American Indians used smoke signals, the Romans used flags and naval forces have used semaphores.

What makes C-BML of interest is the ability to rapidly and efficiently exchange information in support of automated processes, while ensuring the accuracy and validity of the information. This is particularly relevant to today's battlespace needs that involve linking sensors, decision-makers and weapon systems over a widely dispersed battlefield that includes robotic forces.

C2 and simulation interoperability technology does exist today in various forms and with varying levels of technical readiness, as the US Army PEO-STRI's C4I adapter that connects the OneSAF Computer Generated Forces (CGF) with real US C2 systems in a two-way communication. However, most current C2 and Simulation systems communication software still operates in a unidirectional mode that is from the simulation to the C2 systems, and completing the other way with human-in-the-loop taking the orders from the C2 operators and injecting them manually in the simulation.

Where the main challenge lies is in establishing a standard such that C2 systems can interoperate with any simulation system that provides a C-BML interface, with all the advantages that are derived from such standard, in terms of flexibility (interchangeable C2 and/or simulation), cost reduction (no need for human operators, minimum support of legacy software on both the simulation and the C2 systems), efficiency/reliability as the interface is digitized (no verbal/textual communication), etc.

Furthermore, the need for standardization is not at the national level, but at the international level. The ability for national C2 and simulation systems to interoperate with each other and with other national systems will support coalition needs for activities such as mission planning and mission rehearsal. Moreover, there is an increasing use of COTS and GOTS software by many NATO member nations. As standard C-BML interfaces become available for these systems, easier and faster system integration will be possible.

3.2 MSG-048

The beginnings of MSG-048: Initial discussions concerning the creation of a MSG on C-BML started in 2004. The NATO/ET-016 Pathfinder Project demonstrated the technical feasibility of C-BML in 2005 (see SISO 05F-SIW-190). SISO approved the formation of a C-BML Study Group in 2004 and then a C-BML Product Development Group (PDG) in 2005. MSG-048 started in 2006 with the main goals of evaluating the SISO C-BML and assessing it usefulness in support of military operations.

MSG-048 Mandate: The MSG-048 Technical Activity defined a program of work with four main activities:

- Substantiation of the requirements for NATO C-BML;
- Design for a NATO C-BML demonstration;
- Implementation of C-BML interface standard in C2 and simulation systems; and
- Experimentation and assessment of C-BML, including final demonstration.

The latter activity also called for education to the community of the findings of the MSG-048 Technical Activity – which is the purpose of the MSG-079 C-BML Workshop.

MSG-048 Experimentation programme: The initial MSG-048 experimentation programme schedule to end in 2009, was granted a one-year extension in order to design and conduct the final experimentation and workshop. The history of experiments conducted between 2007 and 2010 and lessons learned are reported in the MSG-048 Final Report. Throughout the course of the MSG-048 Technical Activity, these experiments were characterized by increasing:

- Scenario complexity;
- C2 & simulation system capabilities (e.g. C2-simulation tasking, automatic reporting);
- Interactions across systems (e.g. numbers and types of systems communicating together); and
- Coalition context.

MSG-048 Final Experimentation: The Final experimentation took place in Manassas Virginia, USA in November 2009 and involved active and retired military personnel acting as Operational SMEs. The SMEs participated in mission planning, mission rehearsal and training activities that involved C2 and/or simulation systems from Canada, France, Germany, Great Britain, the Netherlands, Norway, Spain and the United States. The scenarios involved multi-service, multi-national forces including a Canadian UAV company, a French Battalion, a Norwegian Battalion, a UK Air Component and a United States RECCE Squadron. The Netherlands commanded the Opposing Forces. BML infrastructure was provided by the United States in the form of George Mason University's BML server while Germany provided a BML conversion capability via the Command & Control Lexical Grammar (C2LG) Interface.

MSG-048 Final Report: The findings, lessons learned and recommendations of the MSG-048 Technical Activity can be found in the MSG-048 Final Report, planned for release in June 2010. This report provides both operational lessons learned and technical lessons learned and provides recommendations concerning how to move toward the operational deployment of C-BML.

The Follow-on Technical Activity MSG-085: Much work remains to bring C-BML to operational deployment. Therefore, the NATO RTO has approved the formation of a new Modelling & Simulation Group to continue the work on C-BML, started by MSG-048. The MSG-085 Technical Activity will have its kickoff meeting in June 2010.

3.3 Theoretical Views

C-BML can be summarized by the five constituent components that describe military information – also known as the five Ws: WHO, WHAT, WHERE, WHEN and WHY. A simplified description of the 5Ws is as follows:

- WHO – The *organization* that is tasking, being tasked, reporting or being reported on.
- WHAT – The *activity* being tasked or the event reported on
- WHERE – The *location* at which the tasking or reporting takes place
- WHEN – The *time* or *temporal association* at which the activity will occur/has occurred
- WHY – The *Command Intent* and sometimes referred to as the *desired end-state*.

BML Grammar: Work on the Command & Control Lexical Grammar (C2LG) was presented with a focus on why a formal grammar is a necessary component of C-BML. C2LG work provided the first definition of the 5Ws, outlined above.

A grammar is required in order to satisfy the need for unambiguous communication. The question becomes "Which type of grammar is appropriate?" Based on the work of Noam Chomsky, a formal language is based on a formal grammar. The grammar represents the production rules by which one constrains the set of possible expressions to a set of unambiguous expressions, without recursions. Note that two different types of grammars could generate the same set of valid expressions.

The question arises of whether it is more appropriate for C-BML to use *Regular* grammars (i.e. automata) or *Context-free* grammars (i.e. equivalent to finite state automata with memory or push-down automata). These grammars are represented by different sets of production rules. The speaker maintains that Context-free grammars are the appropriate type for C-BML.

It is possible to use the JC3IEDM as the basis for a formal language as the structure is context-free, but some constructs are missing and must be added. Note that JC3IEDM was not intended to be used as a formal language but as a data model. JC3IEDM has been optimized for database needs, not for semantic analysis. C2LG is a context-free grammar and supports semantic analysis.

3.4 C-BML for Air Operations

Air Tasking: Several presentations dealt with experimental work involving C-BML for air operations. C-BML will need to support Air Tasking Orders (ATO), Airspace Coordination Orders (ACO) and will also need to use Airspace Control Means (ACM) for geographical features which may have a temporal validity. A common theme for these presentations was the use of C-BML in support of Joint Land-Air capabilities. C-BML needs to be able to provide a reporting capability in order to construct an Air Picture for use in a C2 cell for mission planning, execution and for assessment purposes. One of the particularities with Air Operations is that many aircraft cannot just remain idle. Fixed-wing aircraft must have default mission routes or holding patterns.

Currently Air Orders from C2 systems are issued as formatted ASCII text structures such as the Allied Data Publication 3 (ADatP-3). The issuing and processing of FRAGOs is applicable to both Air and Land forces.

UAV Operations: STANAG 4586 defines a set of interfaces to the UAV Ground Control Station (GCS). These interfaces include interfaces to the operator (i.e. Human Computer Interface or HCI), to the data link terminal (i.e. Data Link Interface or DLI) and for communication with C2 systems (i.e. Command & Control Interface or CCI). STANAG 4586 specifies the use of a subset of ADatP-3 messages as the basis for the tactical messages between C2 systems and the CCI.

A BML-enabled UAV capability that was part of the MSG-048 final experimentation was presented. This capability allowed for direct tasking of a high-fidelity UAV simulation from a production-version fielded C2 system, with no changes to the C2 system. The functionality included intelligence gathering and fire support tasks and support was also provided for automatic reporting. The BML-enabled UAV capability included a [1]level 9 automation that effectively displaced the control of the UAV from the field (e.g. Company or Battalion) to the Command Post (e.g. Brigade).

[1] Based on Parasuraman & Sheridan, IEEE Transactions on Systems, Man, and Cybernetics – Part A: Systems And Humans, Vol. 30, No. 3, May 2000.

3.5 C-BML for C2 and Robotic Forces Interoperability

C-BML holds much promise for use in the exploration of simulated automated forces, such as UAV employment, when there is a high level of automation (i.e. automatic processes) of the unmanned system. C-BML represents a key enabling technology for achieving higher levels of autonomy – or the ability to reach mission objectives with limited external input. The same approach holds for other types of Unmanned Vehicle Systems (UVS) and robotic systems.

One of the important questions is whether C-BML can impose itself as a standard for real robotic forces control from C2 systems, may be as a tactical level specification when existing standards address only the maneuvering part of control of robotic forces.

3.6 Industry View

Several presentations were given by representatives from industry, which appears to recognize the need for a C-BML standard. Often, national standards rely on international standards, which makes the latter all the more important.

Concerning the C-BML specification, it was pointed out that it is important to separate the language (i.e. semantics) from the transport (i.e. information exchange mechanism). Also, it is important to distinguish between data and information intended for human consumption. For example, although C-BML clearly focuses on machine processing of expressions, C-BML may be required to transport messages that will only be used for display purposes (e.g. Graphical User Interface). However, the automated processing of such information based on category codes and other means may still provide benefits in terms of prioritizing and optimizing the human computer interaction when faced with the situation of information overload.

A formal grammar was sited as an essential component of C-BML. Also, the requirement of adapting C-BML infrastructure to a Service-Oriented Architecture (SOA) will be vital to ensuring an efficient integration of C-BML technologies.

Industry involvement is important to the successful transition toward the deployment of C-BML enabled technologies. Industry needs to be strongly engaged, if not in a leadership role, with clear requirements from the military customers.

3.7 Relations and Impact on the MIP

A comprehensive review of international C2IS standardization bodies was provided. It went in great detail in the MIP organization, its role, cooperation process, products (JC3IEDM and exchange mechanism: DEM, MEM), tec. One of the main purposes of this presentation is to highlight the importance of liaising C-BML with the MIP as the latter is undergoing changes. The underlying idea is that the MIP could actually benefit from the C-BML experience as it is now open to address non operational requirements. The official version of JC3IEDM for block 3 is now 3.0.2 and they are currently open to requirements to be considered as part of block 4. There was a suggestion that C-BML becomes a sub-view of the JC3IEDM.

3.8 Relevance for the Non-Military Domain

There are many similarities between the requirements for C-BML and needs associated with information exchange in support of Crisis Management. A European consortium has been formed to address civilian crisis

management through the definition of a Crisis Management Language (CML). Although the domain is rather different from the military domain, CML has several interesting characteristics:

- Must support conditional orders (do not exist in BML); and
- Some domains are not well-supported (no common symbology, no digitized interfaces, no doctrine, etc.).

CML can be considered as a dialect of C-BML or possibly as a “sister-language”.

3.9 Relevance for NATO Organisations

The NATO Consultation Command & Control Agency (NC3A) expressed their need for C-BML and MSDL in support of activities such as exercise preparation, training and collaborative sensor planning. There is a strong potential for collaboration between the C-BML COI and the [2]Multi-sensor Aerospace-ground Joint ISR Interoperability Coalition (MAJIIC) Programme.

NATO is clearly moving away from free-text toward more structured formats, including XML-based messages. NC3A is planning on exploring the use of C-BML and may propose possible C-BML extensions to the MIP, as required. There is also an interest in integrating a C-BML capability into TOPFAS.

The Coalition Battle Management Services (CBMS) program has been launched by US Joint Forces Command (USJFCOM) and funded by the US OSD Coalition Warfighter Program (CWP). The CBMS initiative is aimed at leveraging the emerging SISO C-BML standard as the basis for a C-BML information exchange infrastructure. This infrastructure could be considered for use as part of the MSG-085 Technical Activity whose mandate is to consider available C-BML infrastructure as part of their experimentation programme.

As the SISO C-BML standard reaches maturity, it should be promoted for adoption as a STANAG. It is worth consideration to start the process of developing a STANAG before the first official version of SISO C-BML is released. The goal for creating a C-BML STANAG was stated to be 2013 by Lionel Khimeche, Chairman of the MSG-085 Technical Activity.

It was suggested that NATO be responsible for formulation the requirements for the C-BML specification.

3.10 Update from SISO C-BML PDG

After having stalled for a while, SISO recently has made great progress toward advancing the C-BML standard. The three-phase development plan is nearing the end of phase 1 – the definition of the data model based on the JC3IEDM. Phase 2 includes the definition of a grammar that allows for the construction of C-BML expressions and much work has been done in parallel to phase 1 in advancing the grammar. Phase 3 deals with establishing a C-BML ontology to further ensure semantic interoperability and proper interoperation of C-BML meaning between C-BML producing and consuming systems.

3.11 Future MSG Activity

A follow-on activity to MSG-048, MSG-085 is scheduled to start its activity in June 2010. It has received a strong endorsement with 10 NATO member nations having voted in favor of this activity, including: Canada,

[2] www.nato.int/docu/update/2007/pdf/majic.pdf

Denmark, France, Germany, Netherlands, Norway, Spain, Turkey, United Kingdom, United States of America, NC3A.

3.12 C-BML – Now or Later

The problem of interfacing C2 and simulation systems has been tackled in different manners before the concept of a (C-BML) standard. The pre-C-BML era has seen a plethora of ad-hoc developments resulting in non-interchangeable systems on both the C2 and the simulations sides, and significant costs for the maintenance of components such as gateways. At the same time during the conference one of the questions raised was why start developing a C-BML interface when the standard has not been released yet, as in the case of the presentation from AMPER (ESP). The answer that was proposed simply suggested that even though C-BML standard is not yet fully defined, it is still advantageous to base any new development on the current version of the specification. The final product is very likely to be closer to the final standard than any other development that do not consider C-BML at all, and the incremental effort to progress that development to fully support the standard once it is released is indeed going to be minimal.

3.13 C-BML Challenges

During the workshop, a number of challenges related to the development and adoption of C-BML. These included technical and operational aspects.

Technical Challenges: Simulation systems vary greatly in terms of complexity, levels of automations, levels of fidelity, domains, echelon and behavior models. Ensuring that simulation results are valid in support of the military activities (e.g. COAA, training etc...) requires great care and validation. For example, considerations such as fair-fight criteria will need to be established and measured to ensure that the simulation results are consistent with the scenario requirements. Also, simulations can generate high reporting rates that (1) are not realistic with respect to real operations and (2) may create an information overload at the C2 system that are not necessarily designed to support faster-than-real-time reporting. Time management also emerged as a critical theme toward ensuring the usefulness of simulation results.

The validation of C-BML expressions will be a key element to ensuring the integrity and exactness of C-BML expressions.

Initialization of simulation systems remains an open issue. In October 2009, SISO released the first version of the Military Scenario Definition Language (MSDL). Currently, MSDL represents the most appropriate means for initializing simulations with environmental and organizational data. However, harmonizing MSDL and C-BML remains an issue that will have to be addressed in future work.

Another technical challenge that was identified was that of the information overload related to the publishing of more and more information, in part collected through the increased sensor presence and amplified through an augmented communications infrastructure. C-BML was identified as a possible means for addressing the information overload problem as new C4I architectures are designed.

As C-BML acts as an interoperability enabler and introduces new capabilities, existing systems need to be upgraded in order to take full advantage of the added functionality. For instance, during the MSG-048 final experimentation event, the UAV reports allowed the Brigade Commander to modify his ORDER (e.g. issue FRAGOs) based on timely, relevant reporting. However, many C2 systems do not allow for the rapid generation of FRAGOs and thus became the bottleneck.

Finally, the main technical obstacle to C2-simulation-robotic system interoperability is the lack of an accepted and approved international standard. The recent SISO C-BML Drafting Group work was presented and well-received as bring the community several steps closer toward achieving that goal.

Operational Challenges: Differences in national tactics, techniques, procedures and doctrine present specific challenges in the definition of *standard* C-BML expressions. For instance, a French *fix* or *move* does not necessarily specify control measures in the same way as a corresponding Norwegian *fix*. Similar experience was reported also in the context of a French-German experiment involving C2 and simulation systems.

The operational community needs to be involved in the process of developing and testing the C-BML standard. Coordination between the simulation and operational communities is difficult due to the limited availability of the former.

Another operational challenge that was identified was the differences in the definition of the WHO across different services. For example, in the US the Army defines the WHO as the unit whereas the Air Force and the Navy define the WHO as the platform.

4.0 SUMMARY

4.1 C-BML – A Work in Progress

C-BML has undergone many transformations since its inception. Its technical readiness level although raised during the MSG-048 activities is still not yet sufficient for operational deployment. However, the initial experimentation concerning the use of C-BML in support of military activities shows great promise – and in many instances even a rudimentary C-BML capability proved better than the alternative of no C-BML at all.

4.2 C2 Community Involvement

C-BML has to adapt to the needs and requirements of the C2 community and not the opposite. Currently, the involvement of the C2 community in the development and experimentation of C-BML has been limited.

4.3 C-BML Scope

Scope issues have arisen in the past. C-BML is not mandated to provide C2-C2 interoperability. The C-BML community needs to better coordinate with C2-community. This does not preclude the C2-community from using elements of C-BML for C2-C2 interoperability, but this should come from interactions between the two groups, possibly within the context of a Community of Interest (COI).

With growing use of Unmanned Air Vehicles (UAV) and other robotic force components, there is significant interest in increasing the levels of autonomy of automated systems. Some of the requirements for achieving higher levels of autonomy are covered by C-BML. Therefore, C2-robotic systems interoperability is being addressed as part of the C-BML standardization effort. Several presentations discussed the use of C-BML as an enabler for interoperation with robotic systems.

4.4 Impact on C2 Systems

In the short term, C-BML technologies should be provided to the C2 systems as means for offering simulation–based capabilities (e.g. Course of Action Analysis) to the C2 system with minor or no required

changes to the existing C2 legacy systems. In the long term, as C-BML technology matures and more advanced capabilities become available, it may be necessary to introduce BML-native interfaces into C2 systems – and this may require modifications to these systems.

5.0 RECOMMENDATIONS

Based on the evaluation of workshop material, the presentations that were given and the discussions that took place, the following recommendations concerning the coordination, development and future use of C-BML are made:

1) MSG-085 should consider creating and organizing a C-BML Community of Interest (COI) as part of its programme of work.

2) The C-BML COI should investigate means to facilitate communication and collaboration between interested industry and government stakeholders.

3) The C-BML COI should also liaise with the industry and national partners to promote a common understanding of what C-BML is and the benefits of utilizing a C-BML approach.

4) The elaboration of an international standard for C-BML is a high priority and should be supported by the C-BML COI through active involvement in C-BML standardization activities.

5) Most if not all of the C-BML COI efforts should be directed toward the development of the SISO C-BML as the standard for C2-simulation & C2-robotic systems interoperability.

6) As part of the SISO C-BML standardization activity, measures should be taken to ensure that coordination with the SISO MSDL Product Development Groups (PDG) is effective, with the intended objective to align both standards.

7) NATO should consider initiating a C-BML STANAG development activity in order to leverage and build upon the SISO C-BML standardization activity and to ensure the latter includes all of the relevant NATO requirements.

8) There needs to be an increased interaction with the operational community in the development of the SISO C-BML standard in concert with the MSG-085 Technical Activity, including coordination with the MIP and NC3A.

9) A significant portion of the C2 systems that exist in the various nations are neither JC3IEDM, nor C2IEDM based, therefore it is essential for the C-BML (future) standard to position itself independently from these two MIP standards.

10) On a technical note, it is recommended that C-BML specification be decoupled from the transport mechanisms, as a C-BML implementation could be used for different applications that may or may not require: web services, publish and subscribe or other communication schemes; asynchronous versus synchronous communications; high or low volume of data transfer; speed of transfer; etc.

Annex A – MSG-079 Programme

NORTH ATLANTIC TREATY ORGANIZATION

RESEARCH & TECHNOLOGY AGENCY

WORKSHOP AGENDA

for the

NATO MODELLING & SIMULATION GROUP MSG-079
2010 Coalition Battle Management Language (C-BML) WORKSHOP

Organized by MSG-048

Covering the following themes:

C2-Simulation Interoperability, C2-Robotic Force Interoperability, BML Experimentation, Crisis Management, Coalition Interoperability

To be held at

FARNBOROUGH, UNITED KINGDOM

24-25 February 2010

This activity is open to NATO Nations, Partnership for Peace (PfP), Mediterranean Dialogue (MD) and Contact Countries (CC)

NORTH ATLANTIC TREATY ORGANIZATION

RESEARCH & TECHNOLOGY AGENCY

Workshop Objectives

This two-day workshop has the following objectives:

- illustrate how the Coalition Battle Management Language satisfies the operational needs of coalition forces;
- provide an overview of the elements that comprise BML, why they are necessary and discuss the related challenges, relevant technologies and various technical approaches associated with BML-enabled solutions;
- inform the NATO Community on the development and use of Coalition Battle Management Language and give an opportunity for the Nations and industry to provide a brief update on their related activities;
- present the goals of MSG-048 as well as the lessons learned from the 2009 experimentation and introduce MSG-085, the follow-on technical activity.

C-BML Background

A Battle Management Language (BML) is an unambiguous language used to command and control forces and systems conducting military operations. BML digitizes command & control information such as orders and plans to be understandable for military personnel, for simulated and robotic forces. In addition, BML provides the capability to exchange the required context through digitized reports for establishing and maintaining situational awareness and a shared common operational picture. BML is particularly relevant in a network-centric environment for enabling mutual understanding. BML must also facilitate Command and Control (C2) to Simulation interoperability in an age where Multi-National distributed integrated capabilities are becoming more common and important.

The MSG-048 was created in 2006 with the primary objective of evaluating the available specifications for a Coalition BML. The initial specification was from the Simulation Interoperability Standards Organization (SISO). MSG-048 also had the goal to assess the operational benefits to the C2 and M&S communities. This activity was conducted over the 2006–2009 timeframe and resulted in a series of experiments that included existing national systems, many of which have been modified to be made compliant with the C-BML specification utilized. Another objective of this Technical Activity (TA) was to provide recommendations to NATO concerning the consideration of SISO C-BML specification for standardization and also to provide inputs to the SISO C-BML Product Development Group in order to enhance and extend the current specification.

The forthcoming MSG-085 technical activity, *C2-Simulation Interoperability*, will start in May 2010 and will be a continuation of the work done in MSG-048.

NORTH ATLANTIC TREATY ORGANIZATION
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MSG-079 Workshop Agenda – Day One AM

Wednesday, 24th February	
08.30–09.00	*REGISTRATION*
	WELCOME & KEYNOTE SPEAKERS *Session Chair – Adam BROOK*
09.00–09.10	**Welcome to NATO MSG-079** *Andy FAWKES, MoD Cap-JTES, UK*
09.10–09.40	**Keynote: Challenges for C2-Simulation Interoperability** *Bharat PATEL, DSTL, UK*
09.40–10.10	**Keynote: NATO Research & Technology Organization and the NMSG** *Adrian VOICULET, MSCO Technical Officer, NATO RTA*
10.10–10.30	*COFFEE BREAK*
	SESSION 1 - BML OPERATIONAL REQUIREMENTS *Session Chair – Adam BROOK*
10.30–10.50	**Operational Requirements for a Coalition-BML** *Major Kevin GALVIN, UK Army*
10.50–11.10	**The Swedish Armed Forces Operational Challenges for Command and Control** – *Major Ulf JINNESTRAND, Swedish Armed Forces HQ*
11.10–11.30	**Discussion on Operational Requirements for Coalition BML** *Led by Major Kelvin GALVIN & Major Ulf JINNESTRAND*
	SESSION 2 - MSG-048 (C-BML) TECHNICAL ACTIVITY *Session Chair – Adam BROOK*
11.30–11.50	**MSG-048 (C-BML) Goals & Objectives** *Lionel KHIMECHE, DGA, FRA*
11.50–12.10	**MSG-048 (C-BML) 2009 Experimentation** *Nico DE REUS, TNO, NLD*
12:10–12.30	**Lessons Learned from NMSG-048** *Dr. Kevin HEFFNER, Pegasus Simulation Services Inc., CAN*
12.30–13.30	*LUNCH*

NORTH ATLANTIC TREATY ORGANIZATION
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MSG-079 Workshop Agenda – Day One PM

Wednesday, 24th February	
	SESSION 3 – BML IN THEORY AND PRACTICE *Session Chair – Nico DE REUS*
13.30–14.00	**What is C-BML? An Overview** *Ole Martin MEVASSVIK, FFI, NOR*
14.00–14.30	**Creating a BML Software Infrastructure** *Dr. J. Mark PULLEN, GMU C4I Center, US*
14.30–15.00	**Command & Control Lexical Grammar – Why We Need a Grammar** *Dr. Ulrich SCHADE, FKIE, GER*
15.00–15.30	*COFFEE BREAK*
	SESSION 4 – BML COALITION DEVELOPMENTS *Session Chair – Nico DE REUS*
15.30–16.00	**Developing Coalition BML for Air Operations** *Adam BROOK, QinetiQ, UK*
16.00–16.30	**Using BML to Command & Control UAV Systems in a Coalition** *Marc ST-ONGE, Canadian Signals Inc., CAN*
16.30–17.00	**Developing National Systems to Use Coalition Battle Management Language** - *Dr. Michael HIEB, GMU C4I Center, US*
17.00–17.30	*RECEPTION*

NORTH ATLANTIC TREATY ORGANIZATION
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MSG-079 Workshop Agenda – Day Two AM

Thursday, 25th February 2010	
	SESSION 5 – PERSPECTIVES ON BML *Session Chair – Dr. Michael HIEB*
08.30–08.40	**Welcome & Agenda Review** *Dr. Michael HIEB, GMU C4I Center, US*
08.40–09.10	**A Common Simulation Framework Perspective on BML** *Colin RAYMENT, SEA, UK*
09.10–09.40	**An Industry-Perspective on BML** *Patrick DECHAMPS, EADS Defence, FRA*
09.40–10.10	**Extending BML to Crisis Management** *Per M. GUSTAVSSON, SAAB Training Systems, SWE*
10.10–10.30	***COFFEE BREAK***
	SESSION 6 – C2-SIMULATION INTEROPERABILITY *Session Chair – Dr. Michael HIEB*
10.30–11.00	**C4ISR-Simulation Convergence – Opportunities and Challenges for Exploiting (C-)BML in NATO** – *Dr. Hans JENSE, NC3A*
11.00–11.30	**Use of C-BML in French-German C2-Simulation Coupling Experiments** – *Dr. Eckehard NEUGEBAUER, IABG, GER*
11.30–12.00	**The Dutch Perspective on C2-Simulation Coupling** *Major John JANSSENS, Simulation Expertise Centre-MoD, NLD*
12.00–12.30	**Command and Control Course of Action Analyser Interoperability** *Dr Beatriz GARMENDIA-DOVAL, AMPER, ESP*
12.30–13.30	***LUNCH***

NORTH ATLANTIC TREATY ORGANIZATION
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MSG-079 Workshop Agenda – Day Two PM

Thursday, 25th February 2010	
	SESSION 7 – JC3IEDM & BML *Session Chair – Dr. Kevin HEFFNER*
13.30–14.00	**The Future of JC3IEDM** *Dr. Michael GERZ, FKIE, GER*
14.00–14.30	**Canadian Forces Virtual Command and Control Interface (VCCI)** *Captain Chris TAFF, DnD, CAN*
14.30–15.00	**SIMCI – An Update on US ARMY BML Activity** *Dr. Stan LEVINE, US ARMY SIMCI, US*
15.00–15.30	***COFFEE BREAK***
	SESSION 8 – OTHER BML RESEARCH ACTIVITIES *Session Chair – Dr. Kevin HEFFNER*
15.30–16.00	**Research Results Leading to Coalition Battle Management Services (CBMS)** – *Dr. Andreas TOLK, Old Dominion University, USA*
16.00–16.30	**Update on Emerging SISO C-BML Standard** *Saikou DIALLO, VMASC-Old Dominion University, USA*
16.30–17.00	**Coalition Battle Management Services (CBMS) in the Context of US Joint Forces Command** – *Warren BIZUB, JFCOM J7, USA*
17.00–17.20	**NATO MSG-085 – C2-Simulation Interoperability, The Way Forward** *Lionel KHIMECHE, DGA, FRA*
17:20–17:30	**Closing Remarks** *Lionel KHIMECHE, DGA, FRA*
17.30	***ADJOURN***

NORTH ATLANTIC TREATY ORGANIZATION

RESEARCH & TECHNOLOGY AGENCY

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